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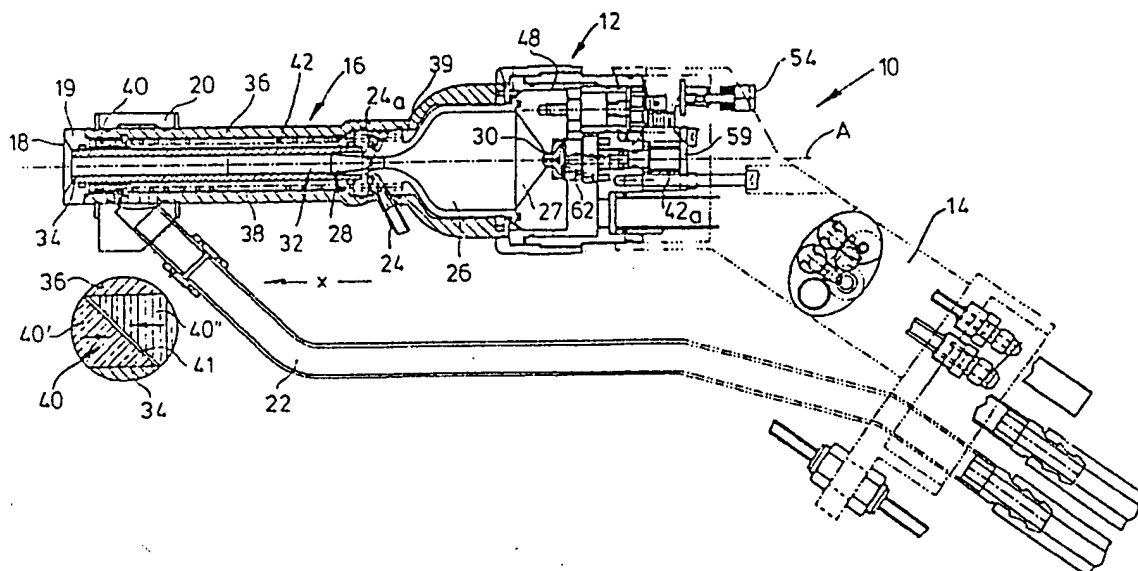
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(54) **DISPOSITIF DE PROJECTION A LA FLAMME ET PROCEDE  
DE PROJECTION A CHAUD**

(54) **FLAME SPRAYING APPARATUS AND THERMAL SPRAYING  
PROCESS**



(57) Dispositif de projection à la flamme, en particulier pistolet de projection à la flamme haute vitesse (10). Il sert à la projection à chaud de matériaux pulvérisés métalliques et non métalliques sous forme de poudre ou de fil à l'aide d'une flamme comprenant un liquide ou un combustible gazeux et un gaz oxydant. Produite dans une chambre de combustion (26) cette flamme est accélérée dans un tube d'étranglement (34). Le dispositif comporte une torche comptant au moins trois parties, soit la chambre de combustion (26), le tube d'étranglement (34) ainsi et un passage confinant la flamme (32). Le tube d'étranglement (34) est installé de manière

(57) A flame spraying apparatus, in particular a high-velocity flame spray gun (10), for the thermal spraying of metallic and non-metallic spray materials in powder or wire form by means of a flame comprising a liquid or gaseous fuel and an oxidation gas, which flame is produced in a combustion chamber (26) and accelerated in a constriction tube (34), has a water-cooled torch system which includes at least three parts, with combustion chamber (26), a constriction tube (34) and a flame constriction passage (32). The constriction tube (34) is mounted interchangeably and is associated with at least one seal (40) which is subjected to the pressure



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interchangeable et est associé avec au moins une joint d'étanchéité (40) qui subit l'effet de pression d'un mécanisme de stockage de la force (42). En plus du joint d'étanchéité (40) du tube d'étranglement inséré (34), il y a au moins un ressort hélicoïdal (42) ou au moins un ressort à lame (66) qui joue le rôle de mécanisme de stockage de la force.

effect of a force storage means (42). Associated with that seal (40) for the inserted constriction tube (34) is at least one helicoidal spring (42) or at least one leaf spring (66) as the force storage means.

Abstract

A flame spraying apparatus, in particular a high-velocity flame spray gun (10), for the thermal spraying of metallic and non-metallic spray materials in powder or wire form by means of a flame comprising a liquid or gaseous fuel and an oxidation gas, which flame is produced in a combustion chamber (26) and accelerated in a constriction tube (34), has a water-cooled torch system which includes at least three parts, with a combustion chamber (26), a constriction tube (34) and a flame constriction passage (32). The constriction tube (34) is mounted interchangeably and is associated with at least one seal (40) which is subjected to the pressure effect of a force storage means (42). Associated with that seal (40) for the inserted constriction tube (34) is at least one helicoidal spring (42) or at least one leaf spring (66) as the force storage means.

The invention concerns a flame spraying apparatus, in particular a high-velocity flame spray gun, for the thermal spraying of metallic and non-metallic spray materials in powder or wire form by means of a flame comprising a liquid or gaseous fuel and an oxidation gas, which flame is produced in a combustion chamber and accelerated in a constriction tube. The invention also concerns processes for spraying materials of that kind.

A simple safety torch for powder flame spraying having feed passages for combustion gas and for oxidation and carrier gas in a torch body having an injector with a powder feed passage is disclosed for example in Swiss patent specification No 451 662. That torch is provided with a collar of the powder feed device, the collar receiving the neck of the bottle-like powder container, while the powder feed device is in turn screwed in a part of the housing of the torch body and the powder feed passage extends from the powder feed device in the form of a substantially axial bore.

High-velocity flame spray apparatuses and guns for gaseous and liquid fuels have been used for many years for producing dense coatings. In such apparatuses the flame is produced in a combustion chamber and then accelerated by virtue of being constricted in a so-called constriction tube.

Experience with those high-velocity flame spray guns has shown that such apparatuses suffer from relatively serious problems in regard to wear or abrasion, in regard to the spray material clinging in the constriction passage, and in regard to keeping the flame parameters constant. Difficulties also arise with the qualities of the layers which are produced thereby.

In addition the high-velocity flame spray guns which are available on the market are of a relatively complicated structure so that the production costs are very high. Consequently, for cost reasons, flame spray guns of that kind can be used only to a limited degree.

US patent specification 4 342 551 describes a high-velocity torch with ignition system in which the liquid fuel which issues into the combustion chamber is burnt by the oxygen and the resulting flame is

constricted in a narrow tubular passage and thereby accelerated. US patent specification No 4 343 605 also discloses a torch with internal combustion, which also does not involve any particular nozzle-type injection of the fuel into the combustion chamber, with the high-velocity  
5 flame being produced by a constriction effect.

Particular difficulties in relation to high-velocity spray guns are caused by sealing problems in the regions which are subjected to a temperature loading; those sealing problems occur due to the coefficients of expansion of the materials used. Up to the present day, rubber-based  
10 or plastic-based O-rings are generally employed, in regard to which the respective service life is relatively short, in other words, the operating time is reduced.

In consideration of that state of the art the inventor set himself the aim of improving the structure of the flame spraying apparatus referred to in the opening part of this specification, and simplifying  
15 handling thereof; the invention seeks to provide in particular that the above-mentioned sealing problems are eliminated and thus the service life and reliability of apparatuses of that kind is overall increased.

The teachings of the independent claims provide for the attainment  
20 of that object; the appendant claims set forth advantageous developments.

In accordance with the invention the flame spraying apparatus has a water-cooled torch system which includes at least three parts - preferably a combustion chamber, a constriction tube and a flame  
25 constriction passage - , wherein the constriction tube is mounted interchangeably and is associated with at least one seal which is subjected to the pressure effect of a force storage means.

In accordance with further features of the invention associated with the seal for the inserted constriction tube is at least one helicoidal spring - which is therefore of a spiral or helical  
30 configuration - or however a leaf spring or a leaf spring assembly.

It has been found desirable for the coil spring or springs to be mounted in the cooling water passage and for the leaf spring or springs to be mounted in a spring chamber, in which case it or they respectively presses or press at one end against a seal; preferably the assembly uses

sealing rings, in particular paired arrangements thereof, which bear against each other with sloping surfaces and thus can also radially change their configuration without complication.

5 It has been found desirable in connection with a flame spray gun with a spray material inlet, to provide the inlet or intake region for the spray material in powder form, in the constriction tube, with a releasable insert, in particular a non-ferrous metal insert, preferably of copper.

10 In accordance with the invention, a liquid fuel chamber and the valve needle of a needle valve for pressure-dependent control are to be provided in the flow path of the liquid fuel. The needle valve is also controllable by way of a helicoidal spring for enabling or closing off the liquid fuel feed flow, while the needle valve can be opened by the liquid fuel pressure in the liquid fuel chamber and can be closed upon a  
15 drop in pressure.

Instead of the helicoidal spring however it is also possible to use a leaf spring or a leaf spring unit for the needle valve; in particular for that purpose it has been found desirable for the needle valve in the liquid fuel chamber to be subjected to the action of a piston which is  
20 controlled by compressed air, for cutting off the feed flow of liquid fuel.

It will be clear that safety shut-off upon the drop in the liquid fuel pressure can be implemented in accordance with two different methods.

25 One of the particular structural features of the flame spray gun according to the invention is therefore the use of compression springs - such as for example the helicoidal spring or the leaf spring assembly - to compensate for the variation in expansion which occurs at the constriction tube upon an increase in temperature.

30 The invention also provides a process for the thermal spraying of metallic and non-metallic spray materials in powder or wire form by means of a flame comprising a liquid or gaseous fuel and an oxidation gas using the flame spraying apparatus according to the invention, wherein the flame is produced either with a liquid or gaseous fuel comprising an

aliphatic compound such as butane, ethyl alcohol or the like, or however with a liquid or gaseous fuel comprising an aromatic compound such as kerosene, diesel or the like petrochemical products. It is also possible to use liquefied gases.

- 5 It has been found desirable to feed metallic materials to the flame at a quantitative through-put of from 0.1 to 10 kg/h, preferably from 0.5 to 8.0 kg/h, or to feed hard substances in a metallic matrix at a corresponding through-put.

10 The process according to the invention, using the described high-velocity flame spray gun, is used in particular in the chemical industry, in particular in the petrochemical industry, and for the production of anti-corrosion layers in energy production, for example in large-scale firing installations.

15 Further advantages, features and details of the invention will be apparent from the following description of preferred embodiments and with reference to the drawing in which:

Figure 1 is a side view of a high-velocity flame spray gun,

20 Figures 2 and 8 are each a side view of an embodiment of the flame spray gun in longitudinal section taken along the longitudinal axis A thereof,

Figures 3 and 9 are each a plan view of the longitudinal section in Figures 2 and 8 respectively through the longitudinal axis A of the flame spray gun,

25 Figure 4 is a partial longitudinal section corresponding to the view shown in Figure 3 through a combustion chamber and a flame injection passage of the flame spray gun which contains a coil spring for producing a sealing pressure,

30 Figure 5 is a partial longitudinal section through a separation plane between the combustion chamber and a flame constriction passage in relation to the embodiment shown in Figures 2 to 4,

Figure 6 shows a detail on an enlarged scale from Figure 3 with a needle valve controlled by the pressure of the liquid fuel and an atomisation nozzle for the atomisation of liquid fuel with oxygen,



Figure 7 is a partial section on a larger scale than Figure 2 through the region of a powder feed into the flame constriction passage as an example in respect of the arrangement of powder feed tubes or powder feed injectors.

- 5 Figure 10 is a plan view in longitudinal section on a larger scale than Figure 9 on to an embodiment of the flame spray gun with a leaf spring assembly for producing a sealing pressure.

Figure 11 shows a detail on an enlarged scale from Figure 10 of a longitudinal section through the transitional region of the combustion  
10 chamber/flame constriction passage, constriction tube with powder feed location, and leaf spring arrangement, and

Figure 12 is a plan view approximately corresponding to Figure 6 of another embodiment of the needle valve for liquid fuel and an atomisation nozzle system with compressed air.

- 15 Referring to Figure 1 a high-velocity spray gun 10 has a substantially cylindrical central body 12 from which there project on the one hand a handle portion 14 which is inclined at an angle  $\alpha$  relative to the longitudinal axis A of the central body 12, and on the other hand an axial flame guide tube or barrel 16. It can be seen that  
20 at the mouth edge 18 thereof there is a connecting ring 20 for a cooling water outlet tube 22 which goes to the handle portion 14 and adjacent to which a powder feed tube 24 is arranged there; the powder feed tube 24 communicates at the end of the central body 12, which is towards the guide tube 16.

- 25 The central body 12 includes a combustion chamber 26 with an atomisation nozzle 30 for fluid fuel and oxygen, the atomisation nozzle 30 being arranged axially in a chamber end portion 27 which enlarges in a funnel-like configuration therefrom. The combustion chamber 26 tapers in a configuration similar to the neck of a bottle towards the guide  
30 tube 16, to a wear portion 28 in the powder feed region at which the powder feed tube 24 opens. Figure 2 also indicates a further powder feed tube 24<sub>a</sub>.

Adjoining the powder feed region in the flame direction  $x$  is an axial flame passage 32 which extends in a flame constriction tube 34.

The latter is fitted into the flame spray gun 10 and with an outer jacket tube 36 defines a cooling water passage 38 which, at the free end of the guide tube 16, is covered over by a mouth ring 19 of steel, which affords the mouth edge 18.

5        Bearing against the mouth ring 19 is one end of a two-part seal 40 comprising ring portions 40', 40" which bear against each other at inclined surfaces 41; the ring portions 40', 40" are shown in emphasised form below Figure 2 as a portion on an enlarged scale. At its end face which faces in opposite relationship to the flame direction x the seal 10 40 is acted upon by a helicoidal spring 42 - which is therefore of a spiral or helical configuration - and which is mounted in the cooling water passage 38. Figures 3 and 4 show that corresponding seals 40 or ring portions 40', 40" are subjected to a spring means in a further sealing region 44 in the proximity of the combustion chamber 26.

15        Figures 2 through 7 show the structural configuration with a helicoidal spring 42 for compensating for expansion with safety shut-off in the event of a drop in the liquid fuel pressure without using air. The helicoidal spring 42 produces a sealing pressure between the combustion chamber 26 and the flame constriction tube 34. Reference 39 20 denotes cooling passages for water cooling of the combustion chamber 26.

In the embodiment shown in Figure 4 an inserted flame constriction tube 34<sub>a</sub> is arranged downstream of the combustion chamber 26 in the flame direction x. A further sealing region 44 can be seen, as mentioned above, between the combustion chamber 26 and the flame constriction 25 passage 32<sub>a</sub>. A mechanical screw means for an outer casing 48 of the central body 12 is disposed at 46.

Provided on the central body 12 in the rear region at 50 is a cooling water feed line, at 52 a feed line for liquid fuel and at 54 a cable connection for an HF-cable; that high-frequency line 54 permits 30 ignition of the high-velocity flame.

Figure 6 shows a liquid fuel chamber 56 for the feed of liquid fuel to the atomisation nozzle 30 which is followed in opposite relationship to the flame direction x by a pressure plate 58 for a needle valve; adjoining the pressure plate 58 in a holding body or yoke portion 59 is

a further helicoidal spring 42<sub>a</sub> for a valve needle 60 in the liquid fuel feed line to the atomisation nozzle 30. Adjoining the atomisation nozzle 30, in inclined relationship with the longitudinal axis A1 of the atomisation nozzle 30, is an oxygen feed line 62.

5 In the case of this safety system the pressure plate 58 is urged upwardly with the valve needle 60 by the helicoidal spring 42<sub>a</sub> and in that case the through-flow to the atomisation nozzle 30 is closed with the needle valve. When the pressure of the liquid fuel in the liquid fuel chamber 56 reaches the desired pressure the helicoidal spring 42<sub>a</sub>  
10 is urged downwardly and moves the valve needle 60 into the open position; the liquid fuel is atomised with oxygen in the atomisation nozzle 30.

The position of a copper insert 64 as a wearing portion at the outlet of the combustion chamber 26 is clearly illustrated in Figure 7.

15 Figures 8 through 12 show a structural configuration of the flame spray gun 10<sub>a</sub> with leaf spring assemblies 66, 66<sub>a</sub> for expansion compensation purposes and a safety shut-off which is controlled by compressed air. The leaf spring assembly 66 in Figures 8 and 9 for producing a sealing pressure between the combustion chamber 26 and the  
20 constriction tube 34<sub>a</sub> bears against an end or annular surface 67<sub>a</sub> of a spring chamber 67, which surface 67<sub>a</sub> is towards the mouth opening of the gun, and the leaf spring assembly presses against a seal indicated at 40<sub>a</sub>, towards the combustion chamber 26 (see Figure 11). In addition Figure 9 shows a powder feed location 25 in the flame constriction tube  
25 34<sub>a</sub> and an oxygen feed line 51 to the flame spray gun 10<sub>a</sub>.

The flame constriction tube 34<sub>a</sub> is inserted into the water-cooled flame constriction passage 38 and sealed by spring pressure for expansion compensation purposes, that is to say by means of the helicoidal springs 42 or the leaf spring assembly 66; in operation of  
30 the torch the variations in expansion which occur are compensated by the spring pressure of the force storage means 42, 66.

In the case of the safety system shown in Figure 12 a valve plunger 68 is urged downwardly by the compressed air in a compressed air chamber 70, the needle valve is opened and the liquid fuel is fed by way of the

liquid fuel chamber 56 to the needle valve and then to the atomisation nozzle 30 for atomisation with oxygen. The compressed air chamber 70 thus serves for moving the valve plunger 58 downwardly against the force of the leaf spring assembly 56<sub>a</sub> of the valve needle 60 of the needle  
5 valve.

CLAIMS

1. A flame spraying apparatus, in particular a high-velocity flame spray gun, for the thermal spraying of metallic and non-metallic spray materials in powder or wire form by means of a flame comprising a liquid or gaseous fuel and an oxidation gas, which flame is produced in a combustion chamber and accelerated in a constriction tube, characterised by a water-cooled torch system which includes at least three parts, with a combustion chamber (26), a constriction tube (34) and a flame constriction passage (32), wherein the constriction tube is mounted interchangeably and is associated with at least one seal (40, 40<sub>a</sub>) which is subjected to the pressure effect of a force storage means (42, 66).
2. A flame spraying apparatus as set forth in claim 1 characterised in that associated with the seal (40) for the inserted constriction tube (34) is at least one helicoidal spring (42) as the force storage means.
3. A flame spraying apparatus as set forth in claim 1 characterised in that associated with the seal (40<sub>a</sub>) for the inserted constriction tube (34) is at least one leaf spring (66) as the force storage means.
4. A flame spraying apparatus as set forth in claim 1 or claim 2 characterised in that the spring (42) is mounted in the cooling water passage (38) surrounding the constriction tube (34) and is arranged in such a way that it can be pressed against a sealing ring (40) defining said cooling water passage.
5. A flame spraying apparatus as set forth in claim 1 or claim 3 characterised in that the leaf spring assembly (66) which is mounted in a spring chamber (67) bears against one of the annular or end faces (67<sub>a</sub>) thereof and is arranged in such a way that it can be pressed against a sealing ring (40<sub>a</sub>).
6. A flame spraying apparatus as set forth in one of claims 1 through 5 characterised in that the seal (40, 40<sub>a</sub>) comprises at least two

ring portions (40', 40") which embrace the constriction tube (34) and which bear against each other with sloping or inclined surfaces (41) which are inclined with respect to the longitudinal axis (A) of the flame spraying apparatus (10, 10<sub>a</sub>).

7. A flame spraying apparatus with spray material inlet as set forth in at least one of claims 1 through 6 characterised in that the intake region (25) for the spray material in powder form is formed in the constriction tube (34) by a releasable insert (64).

8. A flame spraying apparatus as set forth in claim 7 characterised by a non-ferrous metal insert, preferably an insert (64) formed from copper.

9. A flame spraying apparatus with feed device for liquid fuel as set forth in at least one of claims 1 through 8 characterised in that a liquid fuel chamber (56) and the valve needle (60) of a needle valve for pressure-dependent control are provided in the flow path of the liquid fuel.

10. A flamespraying apparatus as set forth in claim 9 characterised in that a helicoidal spring (42<sub>a</sub>) is associated with the valve needle (60) for opening the feed flow of liquid fuel as the control element and the needle valve is adapted to be open by the liquid fuel pressure in the liquid fuel chamber (56) and closable upon a drop in pressure.

11. A flame spraying apparatus as set forth in claim 9 characterised in that at least one leaf spring (66<sub>a</sub>) is associated with the valve needle (60) for opening the liquid fuel feed as the control element and the needle valve is adapted to be open by the liquid fuel pressure in the liquid fuel chamber (56) and closable upon a drop in pressure.

12. A flame spraying apparatus as set forth in claim 10 or claim 11 characterised in that the needle valve is adapted to be acted upon by a plunger (68) controlled by compressed air, for interrupting the feed flow of liquid fuel in the liquid fuel chamber (56).

13. A flame spraying apparatus as set forth in claim 12 characterised in that the plunger (68) is mounted in an air-tight chamber (70).

14. A process for the thermal spraying of metallic and non-metallic spray materials in powder or wire form by means of a flame comprising a liquid or gaseous fuel and an oxidation gas using the flame spraying apparatus as set forth in one of the preceding claims characterised in that the flame is produced with a liquid or gaseous fuel comprising an aliphatic compound such as butane, ethyl alcohol or the like.

15. A process for the thermal spraying of metallic and non-metallic spray materials in powder or wire form by means of a flame comprising a liquid or gaseous fuel and an oxidation gas using the flame spraying apparatus as set forth in one of claims 1 through 13 characterised in that the flame is produced with a liquid or gaseous fuel comprising an aromatic compound such as kerosene, diesel or the like petrochemical products.

16. A process for the thermal spraying of metallic and non-metallic spray materials in powder or wire form by means of a flame comprising a liquid or gaseous fuel and an oxidation gas using the flame spraying apparatus as set forth in one of claims 1 through 13 characterised in that the flame is produced with liquefied gas.

17. A process as set forth in one of claims 14 through 16 characterised in that metallic materials are fed to the flame at a quantitative through-put of from 0.1 to 10 kg/h, preferably 0.5 to 8.0 kg/h.

18. A process as set forth in one of claims 14 through 17 characterised in that hard substances are fed to the flame in a metallic matrix at a quantitative through-put of from 0.1 to 10 kg/h, preferably 0.5 to 8.0 kg/h.

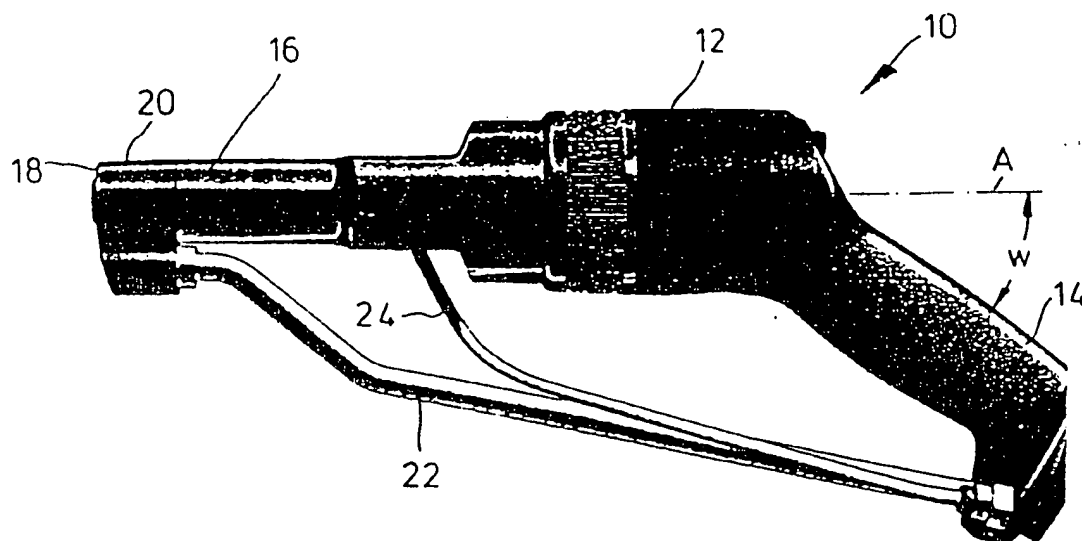
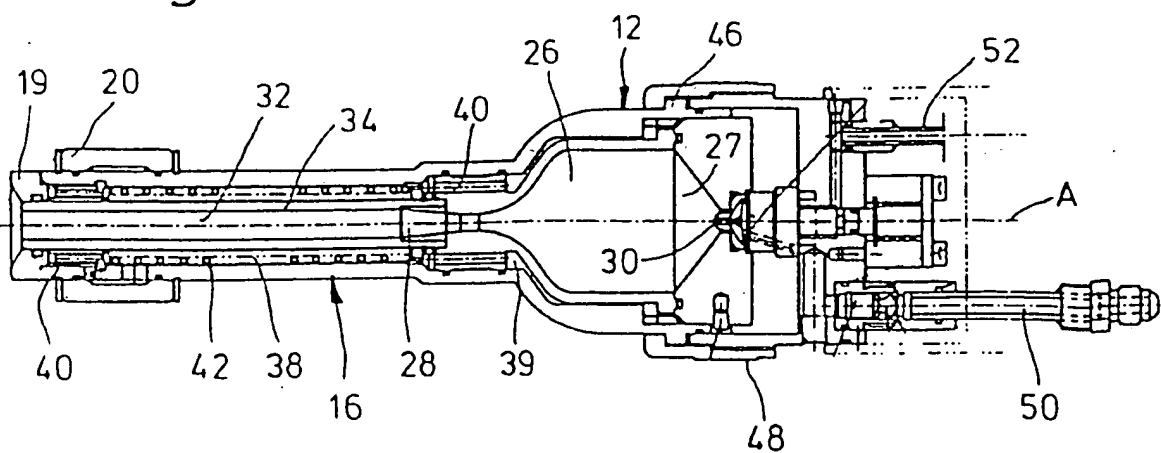


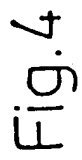
Fig. 1

Fig. 3

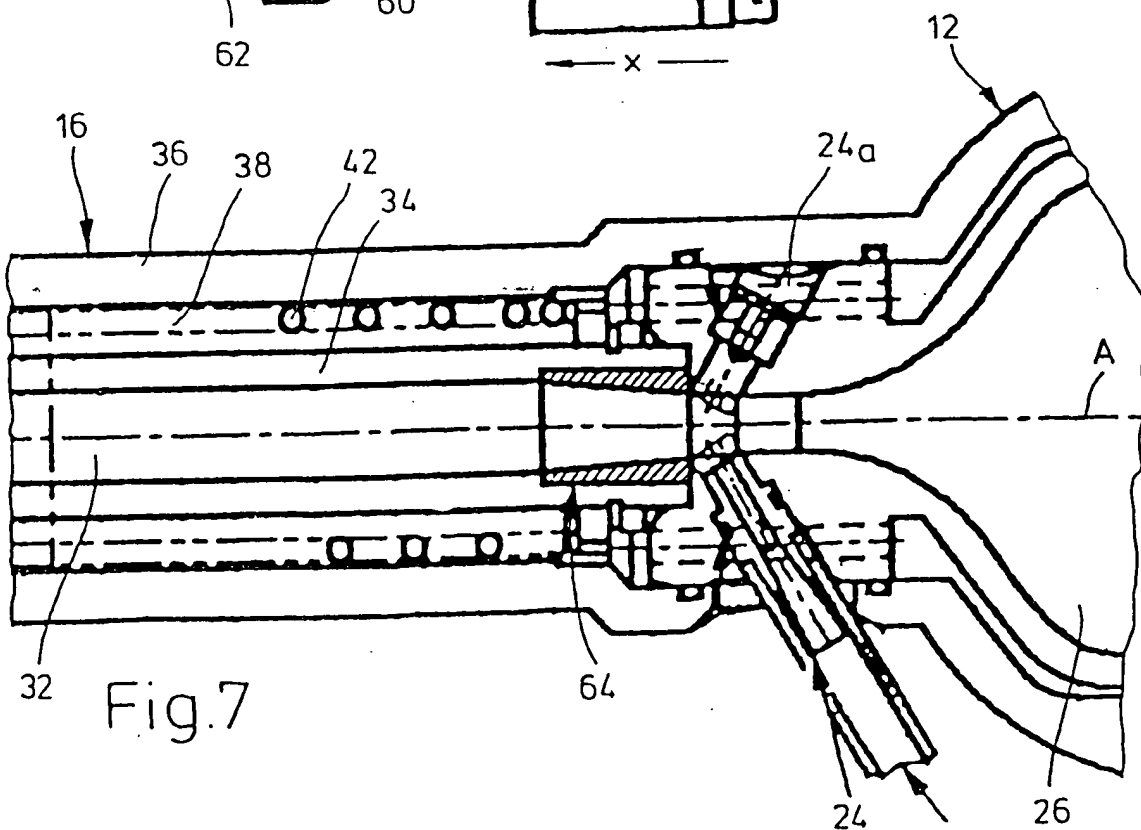
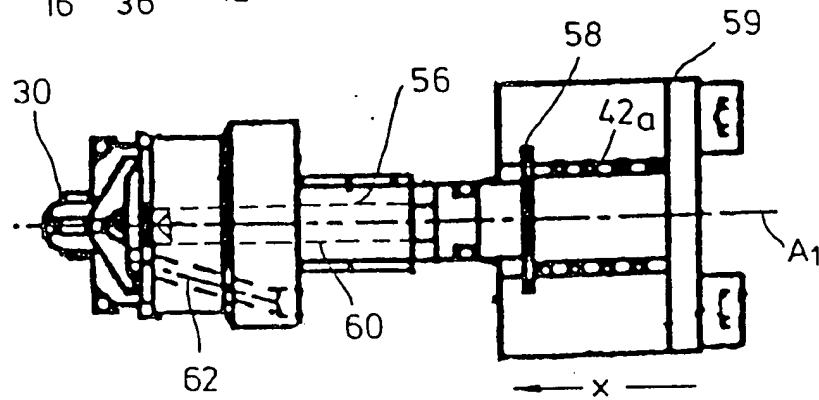
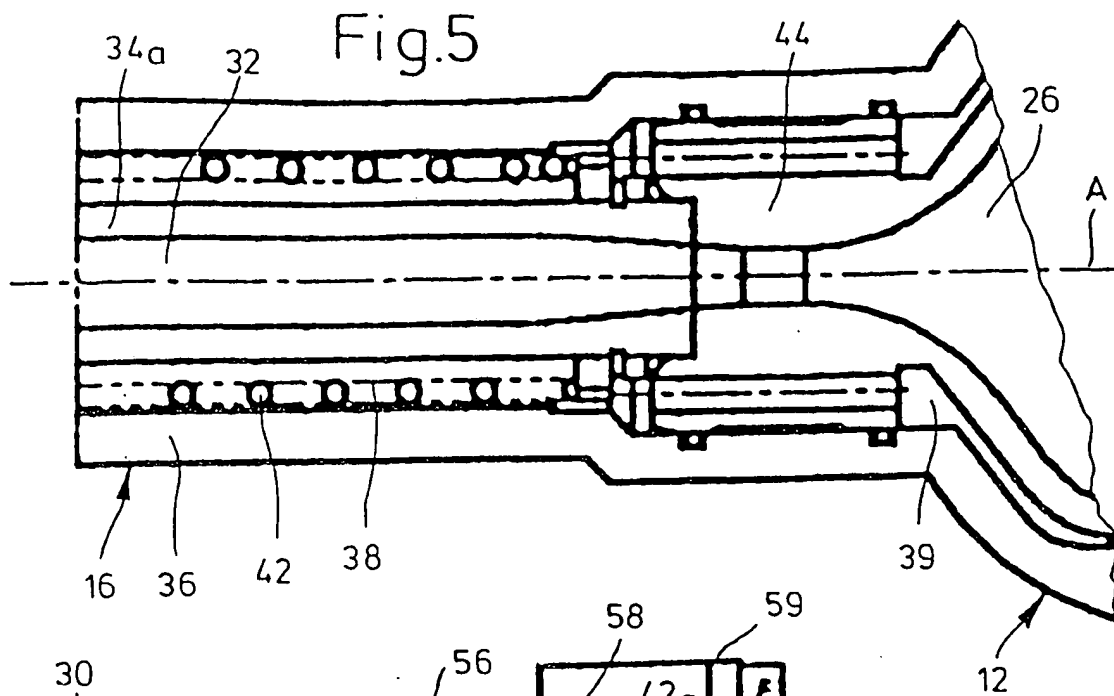


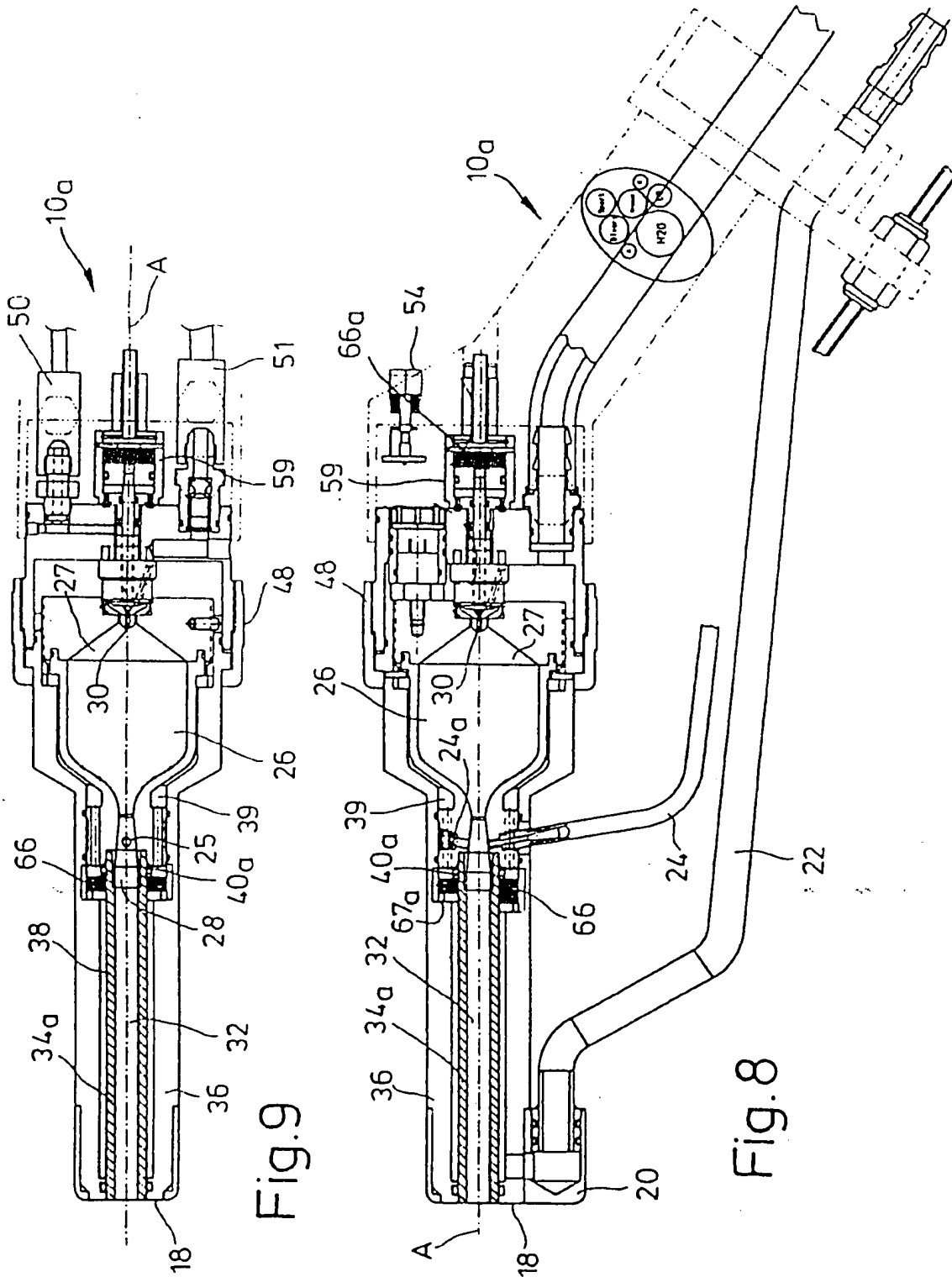
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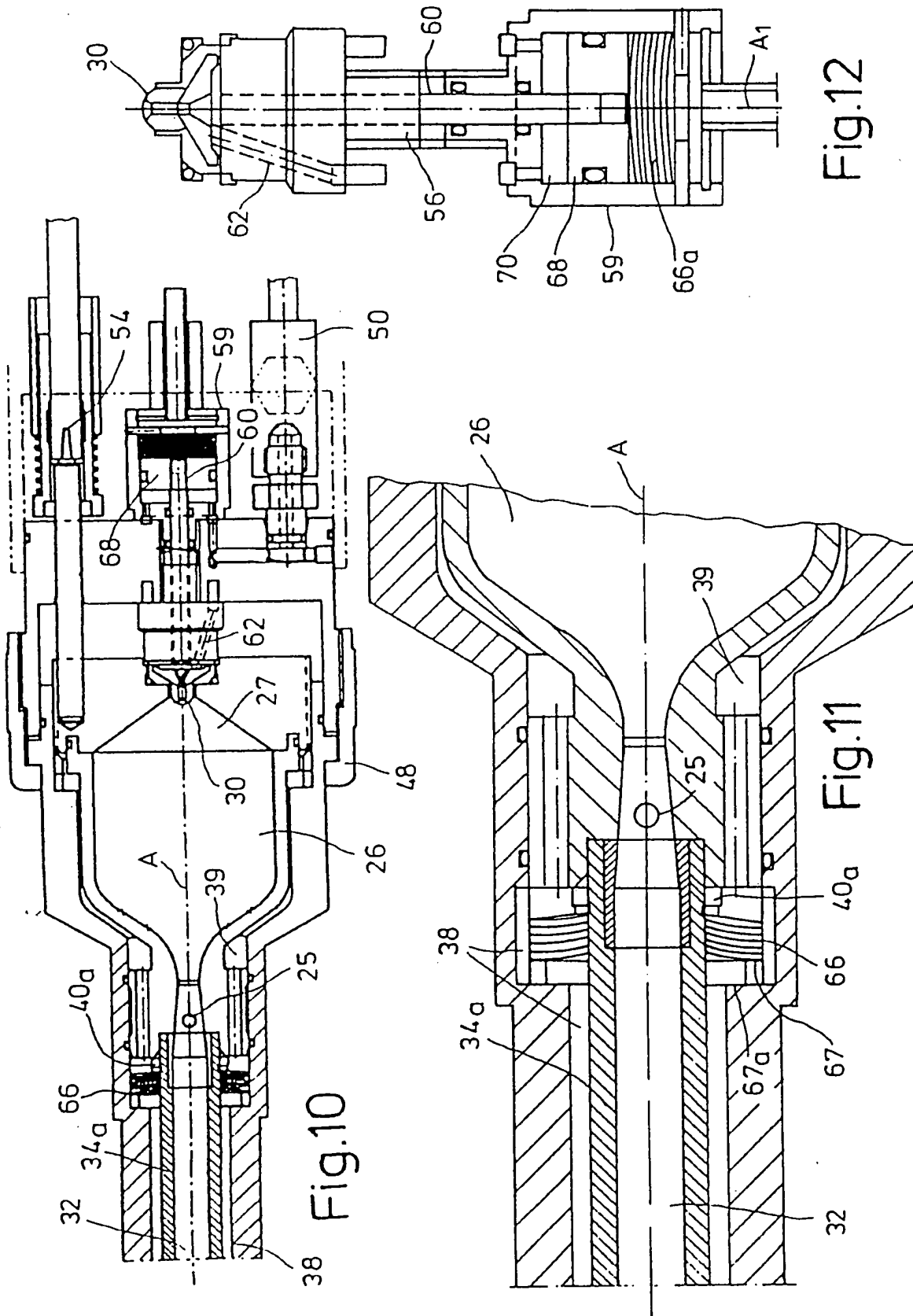


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